Atlantic Richfield Company

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November 4, 2014

Mr. Steven Way
On-Scene Coordinator
Emergency Response Program (8EPR-SA)
US EPA Region 8
1595 Wynkoop Street
Denver, CO 80202-1129

Delivered via e-mail

Subject: October 2014 Monthly Progress Report
Rico-Argentine Mine Site – Rico Tunnels
Operable Unit OU01, Rico, Colorado

Dear Mr. Way,

This progress report describes activities conducted during the month of October, 2014 at the Rico-Argentine Mine Site (site) and activities anticipated to occur during the upcoming month. These activities are organized by task as identified in the Removal Action Work Plan. This progress report is being submitted in accordance with Paragraph 35.a of the Unilateral Administrative Order for Removal Action (the "UAO"), dated March 17, 2011 (effective March 23, 2011).

ACTIVITIES FOR OCTOBER

This section describes significant developments during the preceding period including actions performed and any problems encountered during this reporting period. A summary of the St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study system performance is provided as an attachment.

Site-Wide Activities

- Conducted maintenance on the site access road.
- Coordinated Simultaneous Operations (SIMOPS) with Town of Rico for transport of lead impacted soil to the onsite Soil Lead Repository. The Town did not generate any impacted soil from their pipeline installation activities during October.
- Supported SIMOPS for Voluntary Cleanup Program (VCUP) sampling work entering the St. Louis work area and the onsite Soil Lead Repository.

Task A – Pre-Design and Ongoing Site Monitoring

- Performed additional evaluation of potential improvements on surface water flow data gathering and telemetry. Continued working with Town of Rico on the application for an antenna permit.
- Completed the 2014 Moderate to Low Flow Sampling event on October 24, 2014. The sampling event included 39 groundwater wells, 2 angle bore holes and 9 surface water samples. In addition, 2 equipment blanks, and 6 duplicate samples were obtained. Samples shipped to Pace Analytical Laboratory for analysis.
- Collected groundwater elevation measurements from 42 groundwater monitoring wells throughout the site.
- Collected Dolores River flow measurements at stations DR-2 and DR-7.
- Collected data and manual flow measurements from pressure transducers at DR-3 and DR-6.

- Inspected the St. Louis Ponds System, pond water levels, free-board, and condition of high-level outlet pipes and overflow spillways. The pond network appears to be flowing well and in good condition.
- Collected water elevations from all active St Louis Ponds.
- Conducted Quality Control review of sampling procedures during the Moderate to Low Flow Sampling event.
- Reinstalled and downloaded data from pressure transducer in AT-2.
- Submitted the Peak Flow Summary Monitoring Report which was also uploaded to the SharePoint site.

Task B – Management of Precipitation Solids in the Upper Settling Ponds

- The St. Louis Tunnel discharge was routed to Pond 18 during the month of October, 2014.
- Diverted water into Ponds 11, 12 and 14 following LIDAR scan surveys.
- Continued planning for removal of all remaining mining/mineral processing by-products from Upper Ponds.
- Collected solids samples at Pond 15 and Interim Drying Facility (IDF) for removal treatment options evaluation.

Task C – Design and Construction of a Solids Repository

- Submitted a final version of the Engineering Design and Operations Plan (EDOP) to the Colorado Department of Public Health and Environment (CDPHE) on October 3, 2014 and received "Recommendation of Approval" from the CDPHE on October 8, 2014.
- Submitted a final version of the EDOP to Dolores County (on October 6, 2014) and to the EPA (on October 10, 2014).
- Participated in a meeting with the Dolores County Planning Commission by teleconference on October 27, 2014. The Planning Commission determined the Land Use Application to be complete and a date was set for a public hearing to be held in Dove Creek on December 22, 2014 in the Planning Commission meeting room at the County Building.
- Obtained a third party soil density testing firm to perform independent QA testing during construction per the requirements in the EDOP. Third party density testing was initiated on the Solids Repository starter dike.
- Continued construction activities for the Solids Repository:
  - Excavation from the repository footprint and stockpiling excavated material.
  - Placement of embankment fill for the new access road, utility corridor, and starter dike for the Phase 1 repository.
  - Placement of aggregate base course surfacing on the new access road.
  - Installation of fencing between the new access road and the IDF, including delineators on selected fence posts.
  - Placement of backfill over the storm drain and conveyance lines.

Task D – Hydraulic Control Measures for the Collapsed Area of St. Louis Tunnel Adit

- Completed construction/implementation of Stage 1 for the St. Louis Tunnel hydraulic control system.
- Installed cable from angle well AT-2 to data download station at the lime plant building for ongoing in-tunnel head monitoring.

Task E – Source Water Investigations and Controls

- Continued Blaine Tunnel water depth and flow monitoring behind the Blaine Coffer Dam and Blaine Tunnel Flume.
- Installed fencing and concrete traffic barriers and improved parking and driving areas at the Blaine Tunnel work area.

- On October 15, 2014, responses were submitted to comments received from the EPA on June 12, 2014, regarding the *Evaluation of Source Water Controls Report*.
- Installed replacement battery and safety/security fence for solar panel at Blaine Tunnel water monitoring station.
- CDRMS entered the Blaine and 517 tunnels to close air doors for winter weather preparation on October 16, 2014.
- CDRMS entered the Argentine tunnel for source water flow investigations on October 16, 2014.

Task F – Water Treatment System Analysis and Design

- Continued monitoring activities in accordance with the Performance Monitoring Plan (Appendix B of the St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study Work Plan).
  - Weekly sampling events began on September 16, 2014.
  - Continued operations and maintenance activities.
    - Daily water level measurements
    - Field measurements of select parameters
    - Coagulant injection monitoring
    - Routine maintenance
  - Commissioning of irrigation system for the subsurface flow wetland.
- Submitted Final OMM Plan.
- Continued work on planning and conceptual design of Enhanced Wetland Demonstration Test.
- Controls were implemented to protect the treatment elements from future storm water runoff.
- An aeration system (comprised of a compressor, tubing, and diffusers) was installed and commissioned at the aeration channel.
- Chain-link fencing was extended along the eastern perimeter of the Wetland Demonstration to provide security for the proposed MET station and flow monitoring instrumentation located at DR-3.
- Site telemetry online.
- Met with US Forest Service Land and Minerals Manager (San Juan Forest District) for use of Forest Service land within Pond 12 and Pond 14 for construction of enhanced wetland demonstration components. Forest Service indicated that the wetland components can be constructed within the pond areas with a Special Use Permit.

ACTIVITIES FOR UPCOMING MONTH

This section describes developments expected to occur during the upcoming reporting period, including a schedule of work to be performed, anticipated problems, and planned resolution of past or anticipated problems.

Site-Wide Activities

- Preparation of the site for winter access and monitoring operations.

Task A – Pre-Design and Ongoing Site Monitoring

- Inspect the St. Louis Ponds System, water levels, and free-board.
- Continue work on submittal and processing of the application for a telemetry antenna permit for the Rico office building.

Task B – Management of Precipitation Solids in the Upper Settling Ponds

- Continue routing St. Louis Tunnel discharge to Pond 18.
- Continue planning for removal of all remaining mining/mineral processing by-products from Upper Ponds.

Task C – Design and Construction of a Solids Repository

- Provide public notice of the December 22, 2014 public hearing on the EDOP. Notice to be sent by mail, posted in a local newspaper, and posted at the intersection of State Highway 160 and the site access road.
- Continue construction of the Solids Repository (as long as weather allows), including screening material and placing the starter dike embankment fill.
- Demobilize all construction machinery/personnel from the site for the duration of the winter. Construction to be re-started in the spring.

Task D – Hydraulic Control Measures for the Collapsed Area of St. Louis Tunnel Adit

- Monitor water levels in the tunnel at AT-2 using the re-installed data logger.

Task E – Source Water Investigations and Controls

- Continue Blaine Tunnel water depth and flow monitoring behind the Blaine Coffer Dam and Blaine Tunnel Flume. Install new solar panel for data logger.
- Finalize and submit to EPA responses to EPA's comments on the *Evaluation of Source Water Controls Report*.

Task F – Water Treatment System Analysis and Design

- Complete construction of the wetland demonstration system, including telemetry system installation, treatment system access road construction, finish grading, and installation of Safety Plan components (fencing, signage, windsock, life rings, snow delineators, and egress ropes).
- Install MET station and incorporate into site-wide telemetry system.
- Upgrade aeration system with second compressor and additional diffusers.
- Install pre-fabricated work platforms (stairs, platform supports, and hand rails) at rock drain, aeration channel, and subsurface flow wetland.
- Complete design of the Enhanced Wetland Demonstration.
- Continue scoping additional data needs as necessary related to treatment system alternatives.
- Continue work on planning and conceptual design of removal of all remaining mining/mineral processing by-products from Upper Ponds and grading/lining of selected Upper Ponds for potential conversion to long-term wetlands or open pond lime addition treatment.
- Continue monitoring activities in accordance with the Performance Monitoring Plan (Appendix B of the St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study Work Plan).

If you have any questions, please feel free to contact me at (951) 265-4277.

Sincerely,

Anthony R. Brown
Project Manager
Atlantic Richfield Company

cc: R. Halsey, Atlantic Richfield
T. Moore, Atlantic Richfield
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S. D'Cruz, Esq., Atlantic Richfield
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D. Yadon, AECOM
J. Christner, Weston Solutions
S. Riese, EnSci
A. Cohen, Esq., Davis Graham & Stubbs
W. Duffy, Esq., Davis Graham & Stubbs
A. Piggott, Esq., U.S. EPA
D. McCarthy, Copper Environmental
K. Sessions, AEEC
B. Wheeler, AEEC
B. Florentin, AMEC

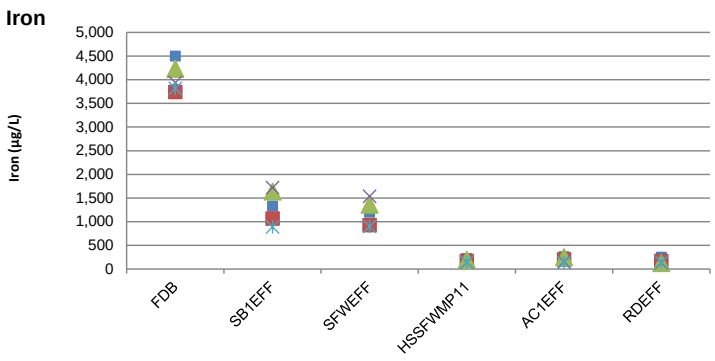
file: Atlantic Richfield Rico Archives, La Palma, CA
AECOM Denver Project File

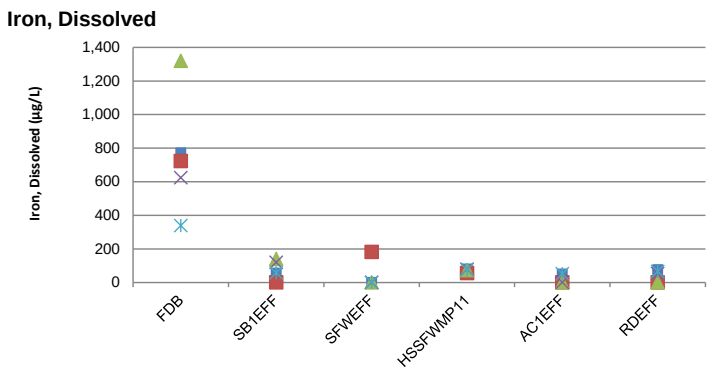
Attachment

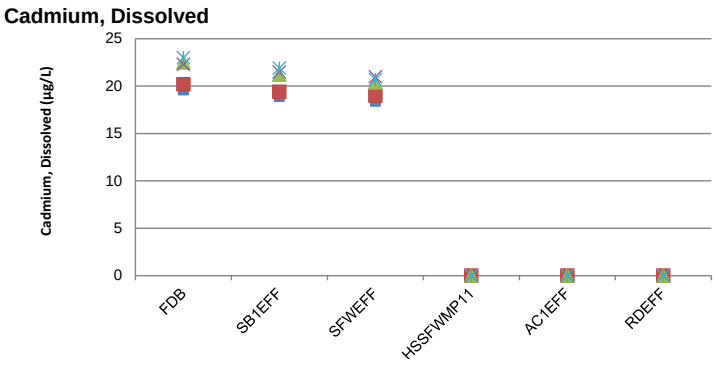
Key Performance Indicators Figures

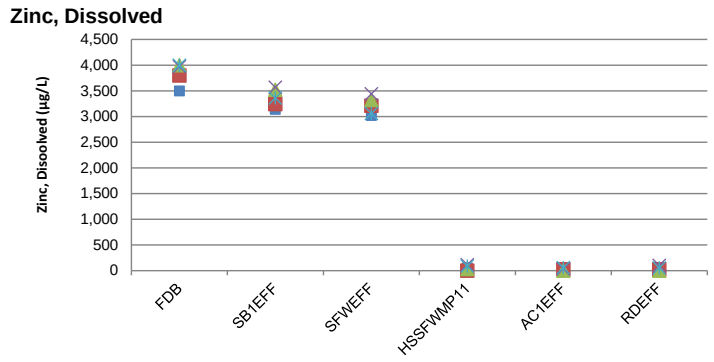
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study

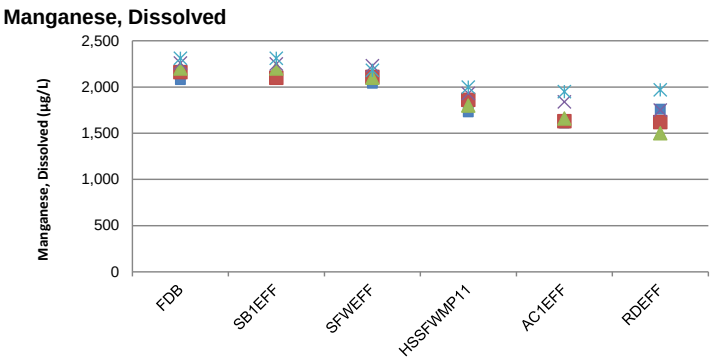
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

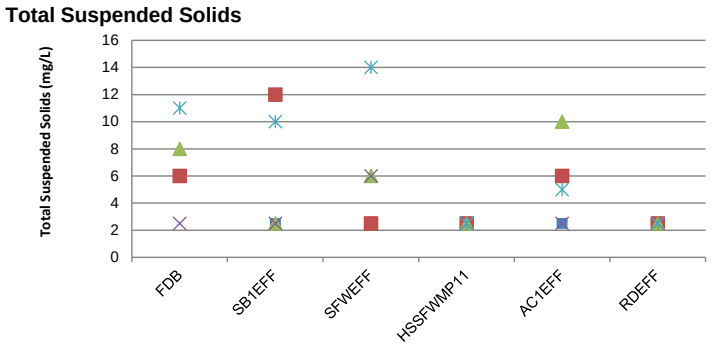


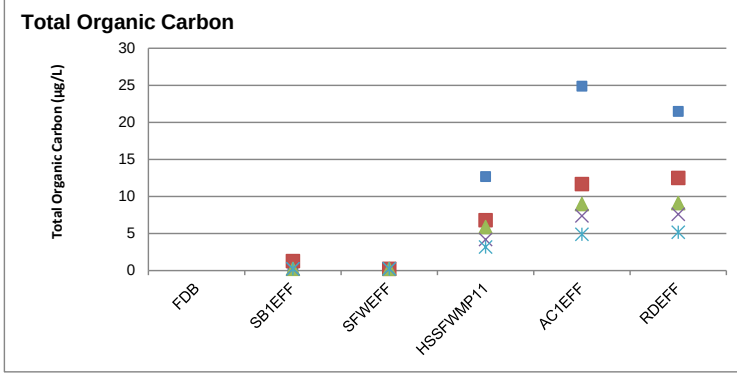


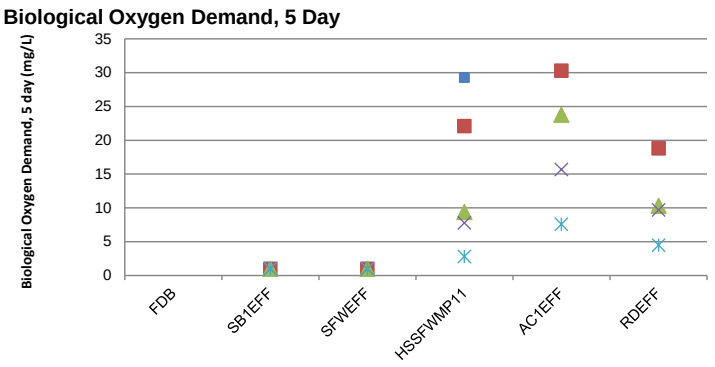


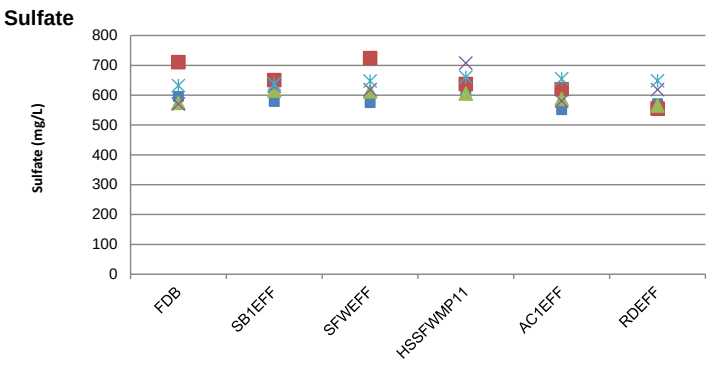


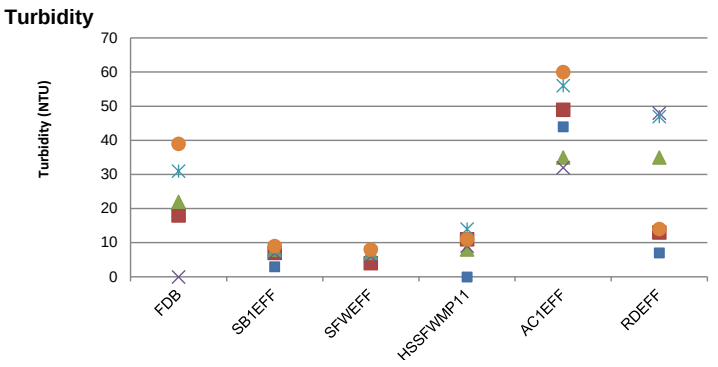


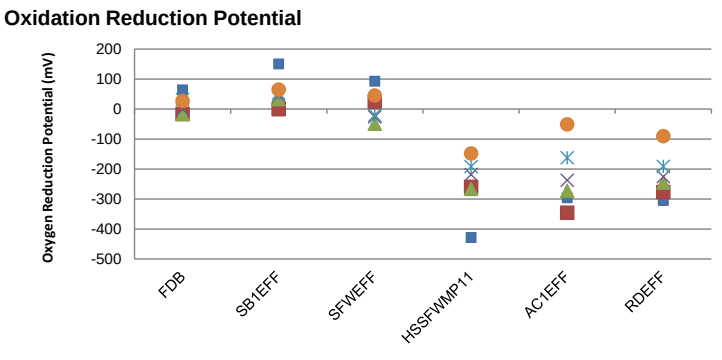


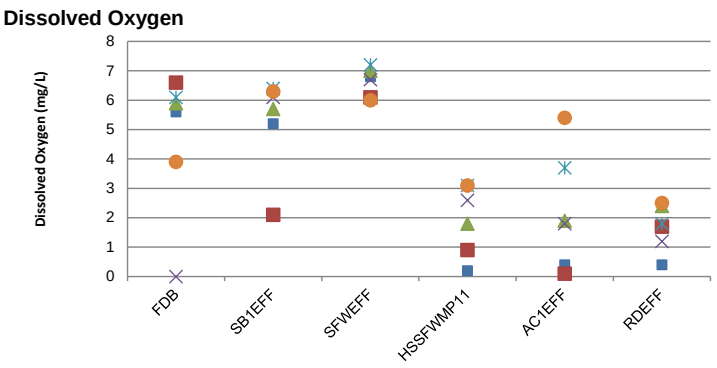


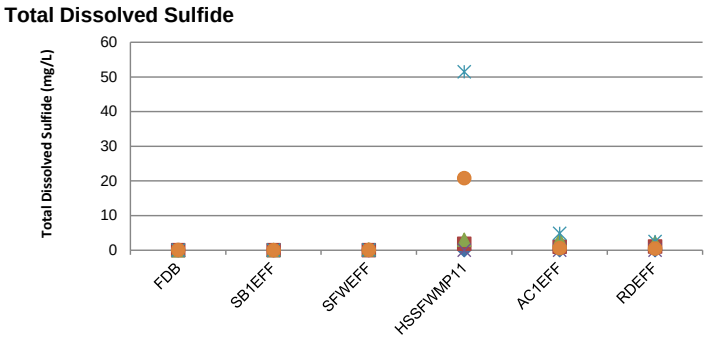


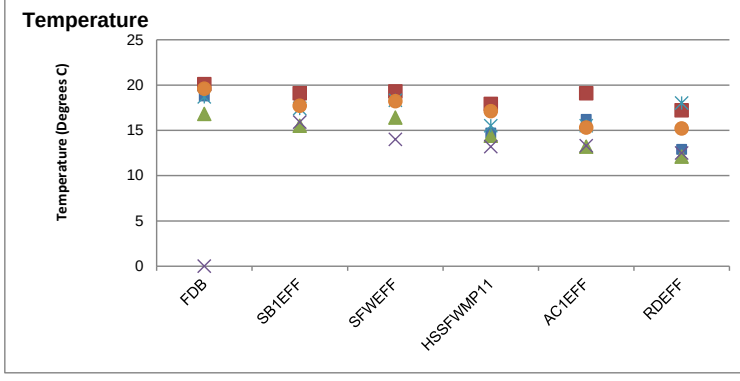


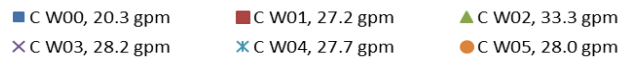










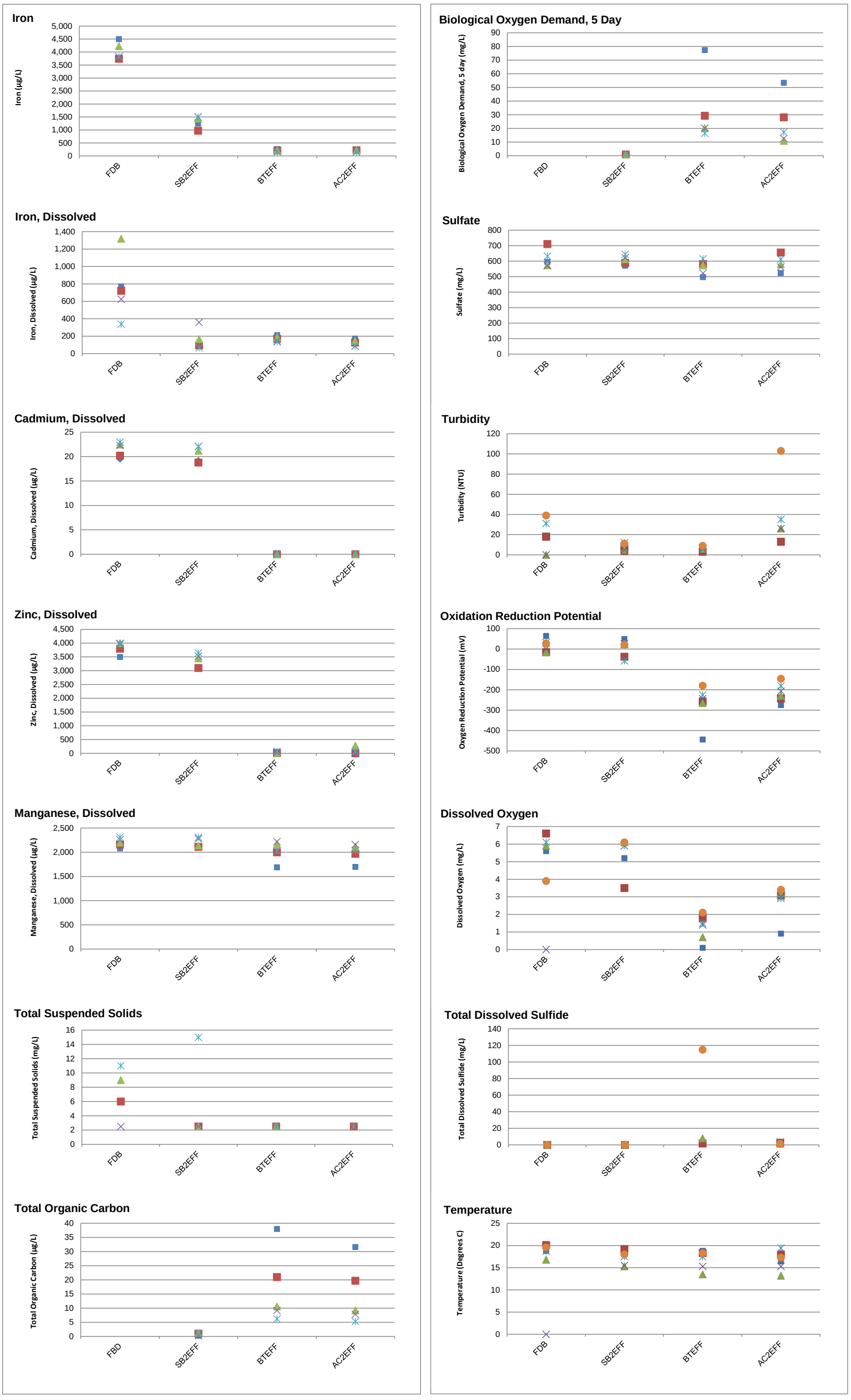


Non detects are reported as <RL and estimated as half the MDL for calculations and graphing.
Values presented for physical and chemical parameters are from field measurements obtained during sampling events.

AC1EFF = Aeration Channel Effluent/Rock Drain Influent
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
RDEFF = Rock Drain Effluent
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent

C = Celsius
C = Colonization Phase
µg/L = micrograms per liter
MDL = method detection limit
mg/L = milligrams per liter
mV = millivolts
NTU = Nephelometric Turbidity Units
RL = reporting limit
W** = Week of Treatability Study Phase

FIGURE 1
HWTT Key Performance Indicators Spatial Series
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

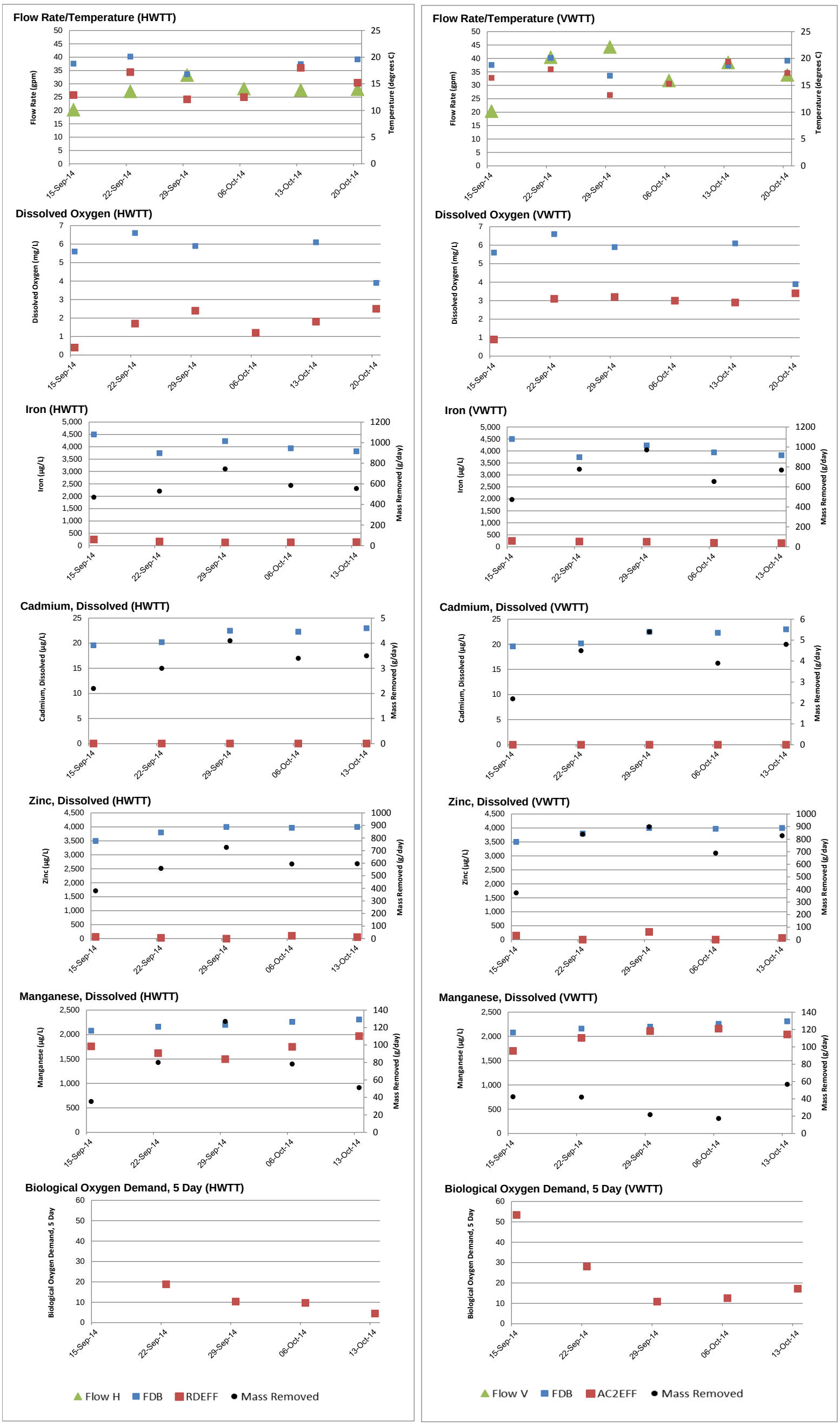


Non detects are reported as <RL and estimated as half the MDL for calculations and graphing.
Values presented for physical and chemical parameters are from field measurements obtained during sampling events.

AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent

C = Celsius
C = Colonization Phase
µg/L = micrograms per liter
MDL = method detection limit
mg/L = milligrams per liter
mV = millivolts
NTU = Nephelometric Turbidity Units
RL = reporting limit

FIGURE 2
VWTT Key Performance Indicators Spatial Series
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01



Non detects are reported as <RL and estimated as half the MDL for calculations and graphing.
Values presented for physical and chemical parameters are from field measurements obtained during sampling events.

AC2EFF = Aeration Cascade Effluent
C = Celsius
µg/L = micrograms per liter
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
gpm = gallons per minute
g/day = grams per day
HWTT = Horizontal Wetland Treatment Train
MDL = method detection limit
mg/L = milligrams per liter
mV = millivolts
NTU = Nephelometric Turbidity Units
RDEFF = Rock Drain Effluent
RL = reporting limit
VWTT = Vertical Wetland Treatment Train

FIGURE 3

HWTT/VWTT Key Performance Indicators Time Series

St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Key Performance Indicators Tables

St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study

Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Table 1. Iron (µg/L)
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Phase	Week	Week of	FLOW H (gpm)	FLOW V (gpm)	FDB	SB1EFF	SFWEFF	HSSFWMP11	AC1EFF	RDEFF	SB2EFF	BTEFF	AC2EFF
C	W00	15-Sep-14	20.3	20.4	4500	1330	1200	223	261	250	1250	266	246
C	W01	22-Sep-14	27.2	40.5	3740	1070	930	168	203	170	971	206	218
C	W02	29-Sep-14	33.3	44.3	4230	1640	1360	194	250	129	1440	216	210
C	W03	06-Oct-14	28.2	31.8	3940	1720	1540	142	156	134	937	171	165
C	W04	13-Oct-14	27.7	38.5	3820	892	900	146	138	144	1500	161	154

NOTES:
Non detects are reported as <RL and estimated as half the MDL for calculations and graphing.
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
Flow H = horizontal treatment train average flow rate
Flow V = vertical treatment train average flow rate
gpm = gallons per minute
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
MDL = method detection limit
OU = operable unit
RDEFF = Rock Drain Effluent
RL = reporting limit
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
µg/L = microgram per liter
W** = Week of Treatability Study Phase

Table 2. Iron, Dissolved (µg/L)
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Phase	Week	Week of	FLOW H (gpm)	FLOW V (gpm)	FDB	SB1EFF	SFWEFF	HSSFWMP11	AC1EFF	RDEFF	SB2EFF	BTEFF	AC2EFF
C	W00	15-Sep-14	20.3	20.4	772	56.4	<50	80.7	50.8	76.2	101	213	174
C	W01	22-Sep-14	27.2	40.5	723	<50	182	56	<50	<50	96.2	172	128
C	W02	29-Sep-14	33.3	44.3	1320	140	<50	74.1	<50	<50	166	189	147
C	W03	06-Oct-14	28.2	31.8	625	120	<50	79.8	<50	53.3	360	147	86.2
C	W04	13-Oct-14	27.7	38.5	339	58.2	<50	77	52.8	66.1	67	135	89.4

NOTES:
Non detects are reported as <RL and estimated as half the MDL for calculations and graphing.
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
Flow H = horizontal treatment train average flow rate
Flow V = vertical treatment train average flow rate
gpm = gallons per minute
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
MDL = method detection limit
OU = operable unit
RDEFF = Rock Drain Effluent
RL = reporting limit
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
µg/L = microgram per liter
W** = Week of Treatability Study Phase

Table 3. Cadmium, Dissolved (µg/L)
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Phase	Week	Week of	FLOW H (gpm)	FLOW V (gpm)	FDB	SB1EFF	SFWEFF	HSSFWMP11	AC1EFF	RDEFF	SB2EFF	BTEFF	AC2EFF
C	W00	15-Sep-14	20.3	20.4	19.6	18.9	18.4	<0.5	<0.5	<0.5	19.1	<0.5	<0.5
C	W01	22-Sep-14	27.2	40.5	20.2	19.4	19	<0.5	<0.5	<0.5	18.8	<0.5	<0.5
C	W02	29-Sep-14	33.3	44.3	22.5	21.2	20.4	<0.5	<0.5	<0.5	21.2	<0.5	<0.5
C	W03	06-Oct-14	28.2	31.8	22.3	21.5	21	<0.5	<0.5	<0.5	22.1	<0.5	<0.5
C	W04	13-Oct-14	27.7	38.5	23	21.9	20.7	<0.5	<0.5	<0.5	22.1	<0.5	<0.5

NOTES:
Non detects are reported as <RL and estimated as half the MDL for calculations and graphing.
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
Flow H = horizontal treatment train average flow rate
Flow V = vertical treatment train average flow rate
gpm = gallons per minute
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
MDL = method detection limit
OU = operable unit
RDEFF = Rock Drain Effluent
RL = reporting limit
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
µg/L = microgram per liter
W** = Week of Treatability Study Phase

Table 4. Zinc, Dissolved (µg/L)
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Phase	Week	Week of	FLOW H (gpm)	FLOW V (gpm)	FDB	SB1EFF	SFWEFF	HSSFWMP11	AC1EFF	RDEFF	SB2EFF	BTEFF	AC2EFF
C	W00	15-Sep-14	20.3	20.4	3500	3140	3020	60.6	<10	62.5	3120	52	148
C	W01	22-Sep-14	27.2	40.5	3800	3240	3210	<10	27	30	3100	12.8	<10
C	W02	29-Sep-14	33.3	44.3	4000	3520	3320	30.3	<10	<10	3450	10.8	279
C	W03	06-Oct-14	28.2	31.8	3970	3570	3440	115	37.9	102	3530	32.7	<10
C	W04	13-Oct-14	27.7	38.5	4000	3360	3060	90.4	60.5	53	3650	76.2	59.4

NOTES:
Non detects are reported as <RL and estimated as half the MDL for calculations and graphing.
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
Flow H = horizontal treatment train average flow rate
Flow V = vertical treatment train average flow rate
gpm = gallons per minute
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
MDL = method detection limit
OU = operable unit
RDEFF = Rock Drain Effluent
RL = reporting limit
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
µg/L = microgram per liter
W** = Week of Treatability Study Phase

Table 5. Manganese, Dissolved (µg/L)
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Phase	Week	Week of	FLOW H (gpm)	FLOW V (gpm)	FDB	SB1EFF	SFWEFF	HSSFWMP11	AC1EFF	RDEFF	SB2EFF	BTEFF	AC2EFF
C	W00	15-Sep-14	20.3	20.4	2080	2100	2040	1730	1610	1760	2110	1690	1700
C	W01	22-Sep-14	27.2	40.5	2160	2100	2110	1860	1630	1620	2110	2000	1970
C	W02	29-Sep-14	33.3	44.3	2200	2200	2100	1800	1660	1500	2140	2170	2110
C	W03	06-Oct-14	28.2	31.8	2260	2250	2230	1930	1840	1750	2280	2220	2160
C	W04	13-Oct-14	27.7	38.5	2310	2310	2180	2000	1950	1970	2310	2030	2040

NOTES:

Non detects are reported as <RL and estimated as half the MDL for calculations and graphing.
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
Flow H = horizontal treatment train average flow rate
Flow V = vertical treatment train average flow rate
gpm = gallons per minute
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
MDL = method detection limit
OU = operable unit
RDEFF = Rock Drain Effluent
RL = reporting limit
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
µg/L = microgram per liter
W** = Week of Treatability Study Phase

Table 6. Total Suspended Solids (mg/L)
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Phase	Week	Week of	FLOW H (gpm)	FLOW V (gpm)	FDB	SB1EFF	SFWEFF	HSSFWMP11	AC1EFF	RDEFF	SB2EFF	BTEFF	AC2EFF
C	W00	15-Sep-14	20.3	20.4	6	<5	<5	<5	<5	<5	<5	<5	<5
C	W01	22-Sep-14	27.2	40.5	6	12	<5	<5	6	<5	<5	<5	<5
C	W02	29-Sep-14	33.3	44.3	8	<5	6	<5	10	<5	9	<5	<5
C	W03	06-Oct-14	28.2	31.8	<5	<5	6	<5	<5	<5	<5	<5	<5
C	W04	13-Oct-14	27.7	38.5	11	10	14	<5	5	<5	15	<5	<5

NOTES:

Non detects are reported as <RL and estimated as half the MDL for calculations and graphing.
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
Flow H = Horizontal Treatment Train average flow rate
Flow V = Vertical Treatment Train average flow rate
gpm = gallons per minute
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
MDL = method detection limit
mg/L = milligram per liter
OU = operable unit
RDEFF = Rock Drain Effluent
RL = reporting limit
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
W** = Week of Treatability Study Phase

Table 7. Total Organic Carbon (mg/L)
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Phase	Week	Week of	FLOW H (gpm)	FLOW V (gpm)	FDB	SB1EFF	SFWEFF	HSSFWMP11	AC1EFF	RDEFF	SB2EFF	BTEFF	AC2EFF
C	W00	15-Sep-14	20.3	20.4	NR	<1	<1	12.7	24.9	21.5	<1	38	31.6
C	W01	22-Sep-14	27.2	40.5	NR	1.3	<1	6.8	11.7	12.5	1	21	19.7
C	W02	29-Sep-14	33.3	44.3	NR	<1	<1	5.9	9	9.1	1.3	10.6	9.2
C	W03	06-Oct-14	28.2	31.8	NR	<1	<1	4.2	7.4	7.6	<1	9.2	7.8
C	W04	13-Oct-14	27.7	38.5	NR	<1	<1	3.2	4.9	5.2	1.1	6.2	5.3

NOTES:
Non detects are reported as <RL and estimated as half the MDL for calculations and graphing.
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
Flow H = Horizontal Treatment Train average flow rate
Flow V = Vertical Treatment Train average flow rate
gpm = gallons per minute
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
MDL = method detection limit
mg/L = milligram per liter
NR = not required
OU = operable unit
RDEFF = Rock Drain Effluent
RL = reporting limit
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
W** = Week of Treatability Study Phase

Table 8. Biological Oxygen Demand, 5 day (mg/L)
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Phase	Week	Week of	FLOW H (gpm)	FLOW V (gpm)	FDB	SB1EFF	SFWEFF	HSSFWMP11	AC1EFF	RDEFF	SB2EFF	BTEFF	AC2EFF
C	W00	15-Sep-14	20.3	20.4	NR	<2	<2	29.3	R	R	<2	77.4	53.4
C	W01	22-Sep-14	27.2	40.5	NR	<2	<2	22.1	30.3	18.8	<2	29.3	28.1
C	W02	29-Sep-14	33.3	44.3	NR	<2	<2	9.4	23.8	10.3	<2	20.3	10.9
C	W03	06-Oct-14	28.2	31.8	NR	<2	<2	7.8	15.7	9.7	<2	20.1	12.6
C	W04	13-Oct-14	27.7	38.5	NR	<2	<2	2.8	7.6	4.5	<2	16.4	17.2

NOTES:
Non detects are reported as <RL and estimated as half the MDL for calculations and graphing.
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
Flow H = Horizontal Treatment Train average flow rate
Flow V = Vertical Treatment Train average flow rate
gpm = gallons per minute
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
MDL = method detection limit
mg/L = milligram per liter
NR = not requrired
OU = operable unit
R = Rejected
RDEFF = Rock Drain Effluent
RL = reporting limit
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
W** = Week of Treatability Study Phase

Table 9. Sulfate (mg/L)
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Phase	Week	Week of	FLOW H (gpm)	FLOW V (gpm)	FDB	SB1EFF	SFWEFF	HSSFWMP11	AC1EFF	RDEFF	SB2EFF	BTEFF	AC2EFF
C	W00	15-Sep-14	20.3	20.4	595	579	575	603	551	571	571	497	523
C	W01	22-Sep-14	27.2	40.5	710	650	724	637	620	555	589	582	656
C	W02	29-Sep-14	33.3	44.3	574	615	612	605	587	565	613	573	580
C	W03	06-Oct-14	28.2	31.8	570	630	618	707	580	618	622	522	562
C	W04	13-Oct-14	27.7	38.5	632	637	647	660	655	648	644	615	612

NOTES:
Non detects are reported as <RL and estimated as half the MDL for calculations and graphing.
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
Flow H = Horizontal Treatment Train average flow rate
Flow V = Vertical Treatment Train average flow rate
gpm = gallons per minute
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
MDL = method detection limit
mg/L = milligram per liter
OU = operable unit
RDEFF = Rock Drain Effluent
RL = reporting limit
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
W** = Week of Treatability Study Phase

Table 10. Turbidity (NTU)
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Phase	Week	Week of	FLOW H (gpm)	FLOW V (gpm)	FDB	SB1EFF	SFWEFF	HSSFWMP11	AC1EFF	RDEFF	SB2EFF	BTEFF	AC2EFF
C	W00	15-Sep-14	20.3	20.4	18	3	5	R	44	7	8	R	R
C	W01	22-Sep-14	27.2	40.5	18	7	4	11	49	13	4	3	13
C	W02	29-Sep-14	33.3	44.3	22	8	7	8	35	35	7	7	16
C	W03	06-Oct-14	28.2	31.8	NM	7	6	9	32	48	5	6	26
C	W04	13-Oct-14	27.7	38.5	31	8	7	14	56	47	12	7	35
C	W05	20-Oct-14	28.0	33.9	39	9	8	11	60	14	11	9	103

NOTES:

Values presented for physical and chemical parameters are from field measurements obtained during sampling events.
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
Flow H = Horizontal Treatment Train average flow rate
Flow V = Vertical Treatment Train average flow rate
gpm = gallons per minute
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
NM = not measured
NTU = Nephelometric Turbidity Units
OU = operable unit
R = Rejected
RDEFF = Rock Drain Effluent
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
W** = Week of Treatability Study Phase

Table 11. ORP (millivolts)
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Phase	Week	Week of	FLOW H (gpm)	FLOW V (gpm)	FDB	SB1EFF	SFWEFF	HSSFWMP11	AC1EFF	RDEFF	SB2EFF	BTEFF	AC2EFF
C	W00	15-Sep-14	20.3	20.4	64	151	93	-428	-296	-305	49	-444	-275
C	W01	22-Sep-14	27.2	40.5	-16	R	24	-259	-346	-277	-38	-257	-243
C	W02	29-Sep-14	33.3	44.3	-17	33	-49	-266	-272	-245	23	-265	-230
C	W03	06-Oct-14	28.2	31.8	NM	46	-26	-218	-237	-225	25	-244	-207
C	W04	13-Oct-14	27.7	38.5	32	54	-20	-192	-162	-191	-58	-226	-182
C	W05	20-Oct-14	28.0	33.9	27	65	45	-148	-51	-90	22	-180	-146

NOTES:

Values presented for physical and chemical parameters are from field measurements obtained during sampling events.
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
Flow H = Horizontal Treatment Train average flow rate
Flow V = Vertical Treatment Train average flow rate
gpm = gallons per minute
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
mV = millivolts
NM = not measured
ORP = Oxidation Reduction Potential
OU = operable unit
R = Rejected
RDEFF = Rock Drain Effluent
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
W** = Week of Treatability Study Phase

Table 12. Dissolved Oxygen (mg/L)
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Phase	Week	Week of	FLOW H (gpm)	FLOW V (gpm)	FDB	SB1EFF	SFWEFF	HSSFWMP11	AC1EFF	RDEFF	SB2EFF	BTEFF	AC2EFF
C	W00	15-Sep-14	20.3	20.4	5.6	5.2	6.8	0.2	0.4	0.4	5.2	0.1	0.9
C	W01	22-Sep-14	27.2	40.5	6.6	2.1	6.1	0.9	0.1	1.7	3.5	1.8	3.1
C	W02	29-Sep-14	33.3	44.3	5.9	5.7	7	1.8	1.9	2.4	6.1	0.7	3.2
C	W03	06-Oct-14	28.2	31.8	NM	6.1	6.7	2.6	1.8	1.2	5.9	1.4	3
C	W04	13-Oct-14	27.7	38.5	6.1	6.4	7.2	3.1	3.7	1.8	5.9	1.5	2.9
C	W05	20-Oct-14	28.0	33.9	3.9	6.3	6	3.1	5.4	2.5	6.1	2.1	3.4

NOTES:

Values presented for physical and chemical parameters are from field measurements obtained during sampling events.
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
Flow H = Horizontal Treatment Train average flow rate
Flow V = Vertical Treatment Train average flow rate
gpm = gallons per minute
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
mg/L = milligram per liter
NM = not measured
OU = operable unit
RDEFF = Rock Drain Effluent
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
W** = Week of Treatability Study Phase

Table 13. Total Dissolved Sulfide (mg/L)
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Phase	Week	Week of	FLOW H (gpm)	FLOW V (gpm)	FDB	SB1EFF	SFWEFF	HSSFWMP11	AC1EFF	RDEFF	SB2EFF	BTEFF	AC2EFF
C	W00	15-Sep-14	20.3	20.4	R	R	R	R	R	R	R	R	R
C	W01	22-Sep-14	27.2	40.5	0	0	0	1.87	0.98	1.05	0.02	1.8	2.66
C	W02	29-Sep-14	33.3	44.3	NM	0.12	0.25	3.03	3.13	2.2	0.11	7.99	1.43
C	W03	06-Oct-14	28.2	31.8	NM	NM	NM	NM	NM	NM	NM	NM	NM
C	W04	13-Oct-14	27.7	38.5	0	0.02	0.06	51.46	4.9	2.5	0.07	R	3.67
C	W05	20-Oct-14	28.0	33.9	0.11	0.03	0.11	20.82	0.61	0.51	0.24	114.7	1.37

NOTES:

Values presented for physical and chemical parameters are from field measurements obtained during sampling events.
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
Flow H = Horizontal Treatment Train average flow rate
Flow V = Vertical Treatment Train average flow rate
gpm = gallons per minute
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
NM = not measured
mg/L = milligram per liter
OU = operable unit
R = Rejected
RDEFF = Rock Drain Effluent
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
W** = Week of Treatability Study Phase

Table 14. Temperature (degrees Celcius)
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Phase	Week	Week of	FLOW H (gpm)	FLOW V (gpm)	FDB	SB1EFF	SFWEFF	HSSFWMP11	AC1EFF	RDEFF	SB2EFF	BTEFF	AC2EFF
C	W00	15-Sep-14	20.3	20.4	18.8	18.1	18.8	14.7	16.2	12.9	18.6	18.8	16.4
C	W01	22-Sep-14	27.2	40.5	20.1	19.1	19.3	17.9	19.1	17.2	19.2	18.3	18
C	W02	29-Sep-14	33.3	44.3	16.8	15.5	16.4	14.4	13.2	12.1	15.3	13.5	13.2
C	W03	06-Oct-14	28.2	31.8	NM	15.9	14	13.2	13.3	12.5	15.5	15.3	15.3
C	W04	13-Oct-14	27.7	38.5	18.7	17.4	18.3	15.5	15.5	18	17.5	17.5	19.4
C	W05	20-Oct-14	28.0	33.9	19.6	17.7	18.2	17.1	15.3	15.2	18	18.3	17.3

NOTES:

Values presented for physical and chemical parameters are from field measurements obtained during sampling events.
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
DEG C = degrees celcius
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
Flow H = Horizontal Treatment Train average flow rate
Flow V = Vertical Treatment Train average flow rate
gpm = gallons per minute
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
NM = not measured
OU = operable unit
RDEFF = Rock Drain Effluent
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
W** = Week of Treatability Study Phase

Table 15. Mass Removal
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Phase	Week	Week of	Analyte Name	FDB (µg/L)	RDEFF (µg/L)	H Δ CONC (µg/L)	H FLOW (gpm)	H FLOW TOTAL (gallons)	H REMOVAL EFFICIENCY (%)	H MASS REMOVAL RATE (g/day)	AC2EFF (µg/L)	V Δ CONC (µg/L)	V FLOW (gpm)	V FLOW TOTAL (gallons)	V REMOVAL EFFICIENCY (%)	V MASS REMOVAL RATE (g/day)
C	W00	15-Sep-14	Cadmium, Dissolved	19.6	<0.5	19.6	20.3	204,700	100	2.2	<0.5	19.6	20.4	205,400	100	2.2
C	W01	22-Sep-14	Cadmium, Dissolved	20.2	<0.5	20.2	27.2	274,300	100	3	<0.5	20.2	40.5	407,800	100	4.5
C	W02	29-Sep-14	Cadmium, Dissolved	22.5	<0.5	22.5	33.3	336,000	100	4.1	<0.5	22.5	44.3	446,900	100	5.4
C	W03	06-Oct-14	Cadmium, Dissolved	22.3	<0.5	22.3	28.2	283,900	100	3.4	<0.5	22.3	31.8	320,400	100	3.9
C	W04	13-Oct-14	Cadmium, Dissolved	23	<0.5	23	27.7	278,900	100	3.5	<0.5	23	38.5	387,700	100	4.8
C	W00	15-Sep-14	Iron	4500	250	4250	20.3	204,700	94.4	470.3	246	4254	20.4	205,400	94.5	473
C	W01	22-Sep-14	Iron	3740	170	3570	27.2	274,300	95.5	529.3	218	3522	40.5	407,800	94.2	777.5
C	W02	29-Sep-14	Iron	4230	129	4101	33.3	336,000	97	744.4	210	4020	44.3	446,900	95	970.7
C	W03	06-Oct-14	Iron	3940	134	3806	28.2	283,900	96.6	585	165	3775	31.8	320,400	95.8	654.4
C	W04	13-Oct-14	Iron	3820	144	3676	27.7	278,900	96.2	555	154	3666	38.5	387,700	96	769.4
C	W00	15-Sep-14	Iron, Dissolved	772	76.2	695.8	20.3	204,700	90.1	77	174	598	20.4	205,400	77.5	66.5
C	W01	22-Sep-14	Iron, Dissolved	723	<50	721.5	27.2	274,300	99.8	107	128	595	40.5	407,800	82.3	131.4
C	W02	29-Sep-14	Iron, Dissolved	1320	<50	1318.5	33.3	336,000	99.9	239.3	147	1173	44.3	446,900	88.9	283.3
C	W03	06-Oct-14	Iron, Dissolved	625	53.3	571.7	28.2	283,900	91.5	87.9	86.2	538.8	31.8	320,400	86.2	93.4
C	W04	13-Oct-14	Iron, Dissolved	339	66.1	272.9	27.7	278,900	80.5	41.2	89.4	249.6	38.5	387,700	73.6	52.4
C	W00	15-Sep-14	Manganese, Dissolved	2080	1760	320	20.3	204,700	15.4	35.4	1700	380	20.4	205,400	18.3	42.3
C	W01	22-Sep-14	Manganese, Dissolved	2160	1620	540	27.2	274,300	25	80.1	1970	190	40.5	407,800	8.8	41.9
C	W02	29-Sep-14	Manganese, Dissolved	2200	1500	700	33.3	336,000	31.8	127.1	2110	90	44.3	446,900	4.1	21.7
C	W03	06-Oct-14	Manganese, Dissolved	2260	1750	510	28.2	283,900	22.6	78.4	2160	100	31.8	320,400	4.4	17.3
C	W04	13-Oct-14	Manganese, Dissolved	2310	1970	340	27.7	278,900	14.7	51.3	2040	270	38.5	387,700	11.7	56.7
C	W00	15-Sep-14	Zinc, Dissolved	3500	62.5	3437.5	20.3	204,700	98.2	380.4	148	3352	20.4	205,400	95.8	372.7
C	W01	22-Sep-14	Zinc, Dissolved	3800	30	3770	27.2	274,300	99.2	559	<10	3799.5	40.5	407,800	100	838.8
C	W02	29-Sep-14	Zinc, Dissolved	4000	<10	3999.5	33.3	336,000	100	726	279	3721	44.3	446,900	93	898.5
C	W03	06-Oct-14	Zinc, Dissolved	3970	102	3868	28.2	283,900	97.4	594.6	<10	3969.5	31.8	320,400	100	688.1
C	W04	13-Oct-14	Zinc, Dissolved	4000	53	3947	27.7	278,900	98.7	596	59.4	3940.6	38.5	387,700	98.5	827

NOTES:
Non detects are reported as less than the Reporting Limit and estimated as half the Method Detection Limit for calculations and graphing.
% = percent
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
g/day = grams per day
gpm = gallons per minute
H = horizontal
H Δ CONC = horizontal change in concentration
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
MDL = method detection limit
OU = operable unit
ppm = parts per million
RDEFF = Rock Drain Effluent
RL = reporting limit
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
V = vertical
V Δ CONC = vertical change in concentration
W** = Week of Treatability Study Phase

Non detects are reported as <RL and estimated as 1/2 MDL for calculations and graphing

Table 16. Hydrogen Sulfide Gas (ppm)
Horizontal and Vertical Wetland Treatment Trains
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study
Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

			Aeration Channel Inlet			Access Road near Aeration Channel (South)			Access Road near Aeration Channel (North)			Access Road near Biotreatment Cell			Aeration Cascade Inlet		
Phase	**Week**	**Week of**	**average**	**minimum**	**maximum**	**average**	**minimum**	**maximum**	**average**	**minimum**	**maximum**	**average**	**minimum**	**maximum**	**average**	**minimum**	**maximum**
C	W00	15-Sep-14	0.033	0	1.1	0.018	0	1.5	0.0024	0	0.2	0.000	0	0	0.002	0	0.4
C	W01	22-Sep-14	0.016	0	0.7	0.025	0	1	0.0000	0	0	0.000	0	0	0.003	0	0.4
C	W02	29-Sep-14	0.032	0	1.7	0.003	0	0.5	0.0000	0	0	0.007	0	1.1	0.004	0	0.7
C	W03	06-Oct-14	0.022	0	3	0.002	0	0.4	0.0000	0	0	0.004	0	0.7	0.006	0	0.6
C	W04	13-Oct-14	0.005	0	0.5	0.000	0	0	0.0000	0	0	0.000	0	0	0.000	0	0
C	W05	20-Oct-14	0.005	0	0.4	0.000	0	0	0.0000	0	0	0.000	0	0	0.000	0	0

NOTES:
AC1EFF = Aeration Channel Effluent/Rock Drain Influent
AC2EFF = Aeration Cascade Effluent
BTEFF = Biotreatment Cell Effluent/Aeration Cascade Influent
C = Colonization
FDB = Flow Diversion Box (Settling Basin No. 1 Influent/Settling Basin No. 2 Influent)
gpm = gallons per minute
HSSFWMP11 = Horizontal Sub Surface Flow Wetland Effluent/Aeration Channel Influent
OU = operable unit
ppm = parts per million
RDEFF = Rock Drain Effluent
SB1EFF = Settling Basin No. 1 Effluent/Surface Flow Wetland Influent
SB2EFF = Settling Basin No. 2 Effluent/Biotreatment Cell Influent
SFWEFF = Surface Flow Wetland Effluent/Horizontal Sub Surface Flow Wetland Influent
W** = Week of Treatability Study Phase

Horizontal Wetland Treatment Train Summary

OCT 2014

St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study

Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

HSSF Wetland Train Report for September-October 2014

Settling Basin

Settling Basin No. 1 is performing as expected under design flows. As anticipated, there are only two significant changes in field parameters in the settling basin. Turbidity decreased from an average influent level of 25.6 NTU to an average effluent level of 7.56 NTU. Additionally, temperature decreased from an average influent level of 18.8 °C to an average effluent level of 17.1 °C. All other field parameters essentially remained unchanged.

Total iron concentrations decreased markedly from an influent average of 4,046 µg/L to an average effluent concentration of 1,330 µg/L. This decrease is consistent with the decrease in turbidity noted above. None of the other metals of concern decreased significantly in the settling basin. Dissolved cadmium concentrations in the influent decreased very slightly from an average of 22.1 µg/L to an average effluent concentration of 21.1 µg/L, while zinc concentrations decreased from 3,936 to 3,584 µg/L. Manganese concentrations were unchanged.

SF Wetland

The SF Wetland is performing as expected under design flows. Turbidity decreased slightly in the surface wetland, from an average influent level of 7.56 ± 1.17 NTU to an average effluent level of 6.4 ± 1.28 NTU, suggesting that it provides additional polishing. Dissolved oxygen concentrations increased slightly in the surface wetland, from an average influent level of 6.04 ± 1.26 mg/L to an average effluent level of 6.68 ± 0.386 mg/L. Temperature did not decrease significantly as water flowed through the surface flow wetland.

Total iron concentrations decreased slightly from an influent average of 1,330 µg/L to an average effluent concentration of 1,186 µg/L. None of the other metals of concern decreased significantly in the surface wetland. Dissolved cadmium concentrations in the influent decreased very slightly from an average of 21.1 µg/L to an average effluent concentration of 19.9 µg/L, while zinc concentrations decreased from 3,584 to 3,210 µg/L. Manganese concentrations were unchanged.

The plants within the SF Wetland have established well prior to the change in seasons. The plants are expected to go dormant through the winter. It is anticipated that the plants in the SF Wetland will grow well next spring.

HSSF Wetland

Up to October 8, the water surface elevation in the HSSF Wetland was kept high to facilitate the establishment of the plants on the surface of the wetland. This increased the hydraulic retention time by > 40% and contributed to excess sulfide generation. On October 8, the water surface elevation was lowered by 6-inches and on October 16 the water surface was again lowered by 6-inches. The gradual lowering of water surface elevation allows for the plants to send roots deeper into the HSSF matrix and remain viable. By lowering the water surface elevation, sulfide production is optimized for the removal of target metals at design flow.

Field parameters changed significantly in the HSSF wetland. Dissolved oxygen levels decreased to <0.5 mg/L and ORP decreased to < -200 mV. This ORP decrease was not evenly distributed, as values near the inlet side (-39 mV) were significantly higher than values near the outlet side (-209). A similarly higher ORP near the inlet was observed in the pilot study, an area that where conditions transitioned between the aerobic inlet and the more anaerobic center of the wetland. The wetland effluent temperature averaged 15.1 °C, a 2 °C decrease from surface wetland effluent temperatures of 17.1 °C.

Both cadmium and zinc total concentrations decreased in the HSSF wetland, from average influent concentrations of 19.9 µg/L and 3,210 µg/L to average effluent concentrations of 3.81 µg/L and 1,123 µg/L, respectively. Metal removal is attributed to the formation of insoluble sulfides inside the HSSF wetland. Dissolved cadmium concentrations were below detection limits in the wetland effluent, while zinc concentration averaged 46 µg/L. The difference between Total and Dissolved concentrations reflects the presence of colloidal sulfides in the wetland effluent.

Manganese concentrations decreased slightly, from average influent concentrations of 2,162 µg/L to an average effluent concentration of 1,854 µg/L.

Aeration Channel

As described above, the operation of the HSSF early in the commissioning produced high sulfide levels in its effluent. Early operation of the aeration channel could not remove these excessive levels of sulfide until three aerators were installed on October 16, 2014. Until that time, water in the aeration channel remained anoxic and contained high levels of sulfide. Dissolved oxygen levels started increasing immediately after their installation, reaching 3.3 mg/L on October 17 and 5.4 mg/L by October 20. Temperature decrease by 0.5 °C in the aeration channel, as the effluent temperature averaged 14.6 °C. Water pH increased slightly in the aeration channel effluent, averaging 7.13 units, compared with values of 6.93 and 6.97 in the surface wetland and HSSF wetland effluents, respectively.

The aeration channel effluent contained a lot of turbidity, as it increased from average influent levels of 9.9 NTU to an average effluent level of 44.9 NTU.

Concentration of the metals of concerns decreased slightly in the aeration channel. Total cadmium concentrations in the influent decreased from an average of 3.81 µg/L to an average effluent concentration of 2.58 µg/L, while zinc concentrations decreased from 1,123 to 834 µg/L. Manganese concentrations decreased slightly, from average influent concentrations of 1,854 µg/L to an average effluent concentration of 1,714 µg/L. This trend is not expected to continue, as sulfide becomes effectively removed in the aeration channel and dissolved oxygen concentrations increase.

Rock Drain

The rock drain did not function as intended since it began receiving water because the aeration channel effluent contained no oxygen and high levels of sulfide[1]. Up until October 15, the rock drain effluent

[1] This is because manganese removal, which the rock drain is designed to achieve, is an oxidative process that requires oxygenated water.

ORP averaged -243 mV and dissolved oxygen averaged 1.71 mg/L. After installation of the aerators, these values increased to -101 mV and 2.6 mg/L, respectively (measured on October 20 and 21).

As a consequence of the inadequate re-oxygenation by the aeration channel, manganese concentrations did not decrease in the rock drain in September and October, from average influent concentrations of 1,714 mg/L to average effluent concentrations of 1,759 mg/L. Manganese removal is not expected to be significant until all the sulfide in the aeration channel is removed and dissolved oxygen concentration are restored to > 5 mg/L.

Field observations indicated that rock collected at the surface of the drain, where atmospheric oxygen can readily exchange at the water surface, had manganese oxide deposits. This means that manganese oxidizing bacteria will colonize the rock drain where conditions are favorable.

From the last week of September onwards, rock drain effluent was dark and contained suspended solids. During that time, turbidity remained elevated, from average influent levels of 44.9 NTU to average effluent levels of 42 NTU.

Rock drain effluent temperature averaged 13.6 °C, a 1.0 °C decrease from average aeration channel effluent temperatures.

Conclusions – HSSF Treatment Train

The performance of the HSSF treatment train has been hampered by the need to keep water levels high so that plants can become established. This had a cascading effect, whereby excessively high sulfide levels produced in the HSSF wetland prevented the proper function of the aeration channel and rock drain. This is expected to change in November as water levels are lowered and design HRT are achieved in the HSSF wetland. Additionally, the aeration channel appears to function as designed after the installation of aerators, resulting in full removal of sulfides and re-oxygenation of mine water. The rock drain is expected to begin removing manganese once the anoxic, sulfidic water has gone through the drain and manganese oxidizers become established.

Vertical Wetland Treatment Train Summary

OCT 2014

St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study

Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

Rico Vertical Wetland Treatment Train Report for September-October 2014

Settling Basin No. 2

Settling Basin No. 2 (SB No. 2) is performing as expected under design and above-design flows. Turbidity decreased from an average influent level of 25.6 NTU to an average effluent level of 7.83 NTU. Temperature decreased from an average influent level of 18.8 °C to an average effluent level of 17.35 °C. No significant changes were observed in any other field parameters.

Total iron concentrations decreased from an average influent concentration of 4,046 µg/L to an average effluent concentration of 1,220 µg/L. Dissolved cadmium concentrations decreased from an average influent concentration of 21.52 µg/L to an average effluent concentration of 20.66 µg/L. Dissolved zinc concentrations decreased from an average influent concentration of 3,854 µg/L to an average effluent concentration of 3,370 µg/L. Dissolved manganese concentrations were unchanged.

Biotreatment Cell

As measured at water quality sonde 08 (WQ08), dissolved oxygen levels have averaged 0.14 mg/L and ORP has averaged -446 mV. ORP and DO measurements recorded by WQ08 are significantly lower than field parameters recorded during sampling events (Table 11 and Table 12, respectively). Biotreatment cell effluent temperature averaged 16.95 °C, a 0.4 °C decrease from the average SB No. 2 effluent temperature of 17.35 °C.

Total cadmium concentrations decreased from an average influent concentration of 20.1 µg/L to an average effluent concentration of 1.22 µg/L. Total zinc concentrations decreased from an average influent concentration of 3,510 µg/L to an average effluent concentration of 747 µg/L. Total manganese concentrations decreased from an average influent concentration of 2,206 µg/L to an average effluent concentration of 2,034 µg/L.

Dissolved cadmium concentrations decreased from an average influent concentration of 20.66 µg/L to below laboratory detection limits. Dissolved zinc concentrations decreased from an average influent concentration of 3,370 µg/L to an average effluent concentration of 36.9 µg/L. Dissolved manganese concentrations decreased from an average influent concentration of 2,190 µg/L to an average effluent concentration of 2,022 µg/L. Metals removal in the biotreatment cell is assumed to be the result of formation and retention of insoluble metal sulfides.

Aeration Cascade

As measured at water quality sonde 09 (WQ09), dissolved oxygen levels have averaged 1.89 mg/L and ORP has averaged -234 mV. ORP and DO measurements recorded by WQ09 are significantly lower than field parameters recorded during sampling events (Table 11 and Table 12, respectively). Aeration cascade effluent temperature averaged 16.6 °C, a 0.35 °C decrease from the average biotreatment cell effluent temperature of 16.95 °C. pH increased from an average influent level of 6.65 S.U. to an average effluent level of 7.0 S.U.. Turbidity increased from an average influent level of 6.4 NTU to an average effluent level of 38.6 NTU. Increases in turbidity are the result of sulfide oxidizing to elemental sulfur.

Total cadmium concentrations were unchanged from the average effluent concentration of 1.22 µg/L. Total zinc concentrations decreased from an average influent concentration of 747 µg/L to an average effluent concentration of 697 µg/L. Total manganese concentrations increased from an average influent concentration of 2,034 µg/L to an average effluent concentration of 2,070 µg/L.

Dissolved cadmium concentrations remained below laboratory detection limits. Dissolved zinc concentrations increased from an average influent concentration of 36.9 µg/L to an average effluent concentration of 97.5 µg/L. Dissolved manganese concentrations decreased from an average influent concentration of 2,022 µg/L to an average effluent concentration of 1,996 µg/L.

Sulfide concentrations decreased from an average influent concentration of 41.5 mg/L to an average effluent concentration of 2.3 mg/L. BOD concentrations decreased from an average influent concentration of 32.7 mg/L to an average effluent concentration of 24.4 mg/L.

Conclusions – Vertical Wetland Treatment Train

VWTT metals removal performance has been within design expectations and is occurring at above-design flow rates (average VWTT flow rate for the September-October period was approximately 40 gpm). Biotreatment cell effluent BOD and total organic carbon concentrations have steadily decreased over the period. The biotreatment cell is more strongly anaerobic than is considered ideal and is generating excessive levels of effluent sulfide. Operational adjustments are being performed with the goal of raising biotreatment cell effluent ORP to above -400 mV (as measured at WQ08). Decreasing influent water temperatures (due to increasing winter heat loss in SB No. 2) are also expected to reduce bacterial activity, increase ORP and reduce sulfide production in the biotreatment cell. Despite receiving excessive levels of sulfide from the biotreatment cell, the aeration cascade has removed >90% of influent sulfide on average.

Wetland Plant Update

OCT 2014

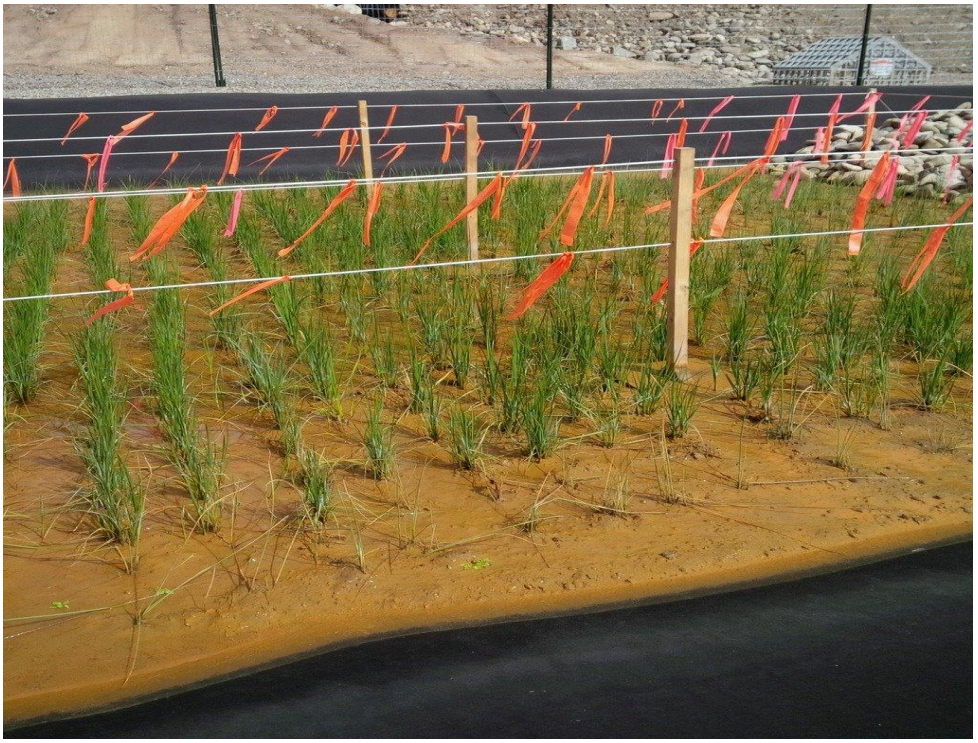
St. Louis Tunnel Discharge Constructed Wetland Demonstration Treatability Study

Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01

RICO WETLAND DEMONSTRATION PROJECT - SF and HSSF WETLAND CELLS

October 15, 2014 Monitoring

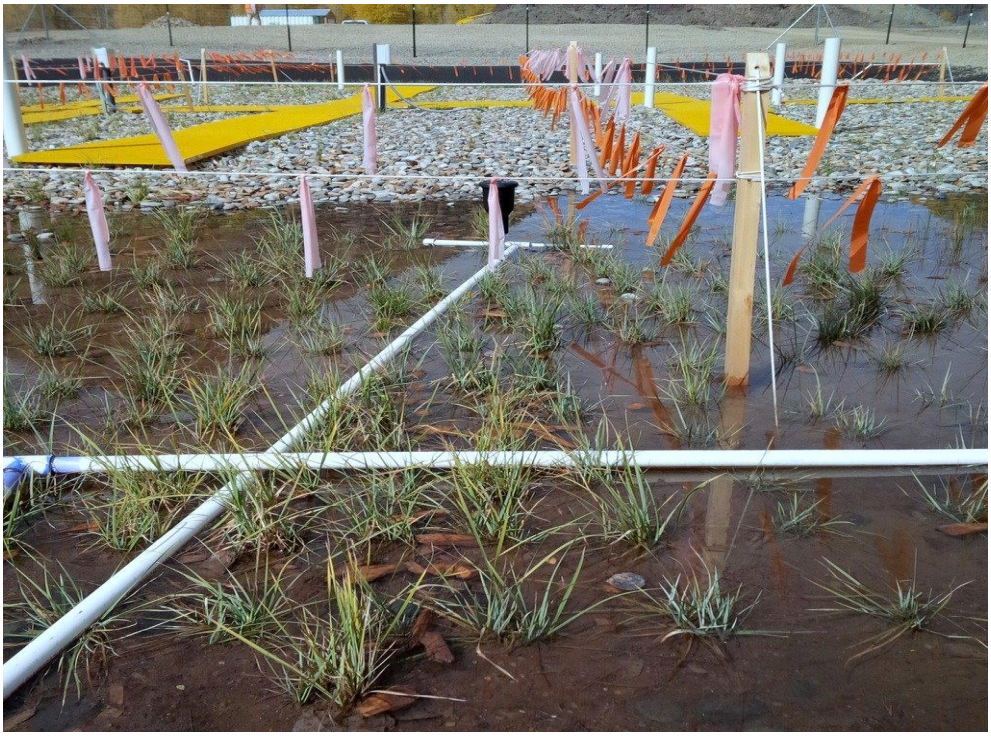
Photograph 1: SF Wetland with Bulrush, Sedge, and Rush Establishing – Looking South



Photograph 2: SF Wetland with Bulrush, Sedge, and Rush Establishing – Looking East

Photograph 3: SF Wetland with Bulrush, Sedge, and Rush Establishing – Looking Northeast

Photograph 4: HSSF Wetland with Bulrush, Sedge, and Rush Establishing – Looking East



Photograph 5: HSSF Wetland Soil Strip with Establishing Sedge

Photograph 6: HSSF Wetland Soil Strip with Establishing Sedge and Rush

Photograph 7: West Side of HSSF Wetland with Establishing Sedge and Rush – Looking South

Photograph 8: North Side of HSSF Wetland Soil Strip with Establishing Seeded Area, Sedge, and Rush